Eating in China: A Matrix for Counting Daily Dietary Intake of Heavy Metals.

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Acknowledgements Page

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Abstract

Cadmium is a notoriously toxic metal widely detected in soils and water of South China. Several recent reports of cadmium polluted rice and vegetables have caused major public concerns on food safety as dietary intake is a major route of exposure to the contaminant. The overall goal of this study was to provide guidance for Chinese to choose their daily food varieties so that individual's daily intake of cadmium may not exceed the limit of 5 micron gram per kg of body weight per day set by the World Health Organization (WHO). The objectives were to compile data on cadmium contents of cereals and vegetables grown in different geographical regions of China, to categorize high cadmium food and vegetables according to their geographical regions, and to develop an excel spreadsheet-based matrix for quantifying daily intake of cadmium via consumption of different types and weights of food and vegetables. The ultimate goal of the project is to develop a smart-phone-based app that can handily monitor the daily cadmium intake

level for individuals and provide alternative choices of food or vegetables of low cadmium contents to maintain one's daily cadmium intake under the limit. Our data compilation showed that Chinese dietary intake of cadmium can be classified to 7 geographic regions according to the levels of cadmium in different types of cereals and vegetables. Individuals of South China where rice is the staple food could easily exceed their daily intake limit of cadmium. Lowering consumption rates of rice, spinach, lettuce and Chinese cabbage is key to reducing the risk of chronic cadmium poisoning. Our study strongly suggested that growing vegetables on lands of low background levels of cadmium may be a strategic solution to the cadmium pollution problem in South China. Background

Heavy metals are metals that have high densities, atomic number or atomic weights. The intake of a small quantity of certain heavy metal is essential to human health, such as iron, manganese, zinc and cobalt. However, toxic heavy metal, including lead, cadmium, mercury and arsenic can cause great harm to human.

There are mainly two ways that heavy metals are accumulated through food intake in human body. Firstly, heavy metals can be found naturally in the earth. The consumption of plants and animals from areas that heavy metal are heavily presented can lead to a more concentrated level in human body. Because most heavy metals can not be eliminated by human body thus they remain in organs. Secondly, many processed foods are contaminated during the preparing step, by using heavy metal contaminated machineries, containers and even transportation facilities. The remained heavy metal inside the body interfere with the functioning of cellular components such as enzymes and structural proteins. The symptoms vary depends on the metal compound

and the dosage. The common ones are nausea, cancer, and the softening of bones, also known as Osteomalacia. One particular famous example is the Itai-itai disease in Japan starting around 1912. The disease was caused by cadmium poisoning due to mining in Toyama Prefecture.

Along with the vast development of industrialization and modernization of agriculture, heavy metal contaminated food intake has become a serious issue and raised broad public concern. Various international and governmental health agencies set up standards for food producers and factories to follow. Nevertheless, there are still foods that are heavy metal contaminated on the market. As a result, people need to be informed about the contamination level of the daily food intake and make healthier food choices. Thus a program that calculates a particular person's heavy metal intake considering age, gender, geographical location and body weight, is very necessary. Base on those information, people can also get valuable suggestions about better dietary choices.

Data

Note: The data tables are divided into three groups. Group one contains information about contaminants in specific food samples, raw food, and different food categories. There are two types of data within group one. Tables like 1.1 only include contaminant level of 12 categories of food in 12 provinces (include lead, cadmium, total mercury, methyl-mercury, total arsenic, and inorganic arsenic). Tables like 1.2 include the level of Pb and Cd contaminants in more specific food samples in 12 provinces.

Table 1.1

各省12种类食物重金属含量														
P229 铅 附表 4-12														
膳食种类	黑龙江	辽宁	河北	陕西	河南	宁夏	上海	福建	江西	湖北	四川	广西	全国平均	
谷类	1.50	6.46	15.74	22.39	4.82	1.79	1.56	1.39	9.36	38.13	67.60	5.17	14.66	
豆类	220.97	285.03	32.16	0.96	1.44	15.75	4.05	3.14	11.67	26.05	17.06	106.11	60.37	
薯类	112.68	307.65	48.41	128.87	20.14	2.73	2.04	1.93	43.34	44.30	10.58	56.37	64.92	
肉类	0.94	427.09	12.25	0.93	21.45	31.30	22.56	0.96	53.15	12.16	3.19	0.82	48.90	
蛋类	0.90	151.48	76.51	12.54	25.73	4.15	3.81	6.98	7.05	64.42	0.38	108.79	38.56	
水产类	220.60	343.63	21.35	32.27	11.79	0.80	25.38	133.32	46.05	16.67	6.42	39.89	74.85	
乳类	0.75	2.12	5.07	4.13	2.70	3.06	0.75	0.75	2.12	10.58	0.75	0.75	2.79	
蔬菜类	0.88	224.81	6.33	15.33	11.21	0.77	11.31	30.16	15.34	42.30	21.59	66.23	37.19	
水果类	0.78	6.17	1.90	5.46	39.14	6.93	4.39	7.69	25.70	2.88	1.82	291.29	32.84	
糖类	0.75	0.75	27.07	1.52	15.80	0.75	0.75	0.75	0.75	0.75	0.75	0.75	4.26	
饮料与水	0.75	5.47	0.75	0.75	3.30	0.75	0.75	1.20	0.75	0.75	0.75	0.75	1.39	
酒类	0.75	4.36	0.75	13.60	2.37	0.75	0.75	0.75	0.75	0.75	0.75	0.75	2.26	

Table 1.1 The amount of Pb found in 12 food categories in 12 provinces

Table 1.2

样品类别	样品名称	Sample name	Pb/（mg/kg）	Cd/（pg/kg）
3-1黑龙江省				
谷类	大米	Rice	0.002	0.53
	馒头	Steamed bun	0.018	0.76
	挂面	Dried noodle	0.010	0.37
	桃酥	Walnut cake	0.021	0.61
	油条	Deep-fried dough sticks	0.034	0.86
	玉米面	Corn flour	0.001	0.25
	合计	Subtotal		
豆类	炖豆腐	Steamed bean curd	0.372	0.29
	千张	Dried bean curd sheets	0.179	0.50
	花生仁	Kernels	0.024	151.66
	合计	Subtotal		
薯类	炖土豆	Stewed potato	0.340	5.63
	炒土豆丝	Stir-fried shredded potato	0.036	5.39
	合计	Subtotal		
肉类	炖肉	Stewed meat	0.030	0.25
	炒肉	Stir-fried meat	0.023	28.09
	鸡肉	Chicken	0.066	0.36
	香肠	Sausage	0.024	0.47
	猪肝	Pork liver	0.024	6929.57
	合计	Subtotal		
蛋类	炒蛋	Scrambled egg	0.007	0.33
	鸡蛋汤	Egg Soup	0.008	0.25
	咸鸭蛋	Salted duck egg	0.011	0.38
	小计	Subtotal		
乳类	牛奶	Milk	0.004	-
	奶粉	Milk powder	0.016	-
	小计	Subtotal		
水产类	鲤鱼	Carp	0.312	0.25
	丝带鱼	Ribbon fish	0.357	12.71
	小计	Subtotal		

Table(Example) 1.2 Levels of lead and cadmium in more specific food samples in 12 provinces(partial data from Heilongjiang province)

Note: In this part, the data of intake habits, including specific food and 12 food classes, for specific areas, ages, and sexes of people, are accessed.

Table 2.1

10个年龄组各类食物的消费量

	Body weight	Cereals	Legumes	Potatoes	Meats	Eggs	Aquatic foods	Dairy products	Vegetables	Fruits	Sugar	Beverages and water	Alcohol beverages	Total
2-7years	17.9	228.3	22.7	27.4	47.1	26.5	37.6	83.9	185.4	75.5	19.6	168.1	4.7	926.9
8-12years	33.1	372.7	27.8	41.1	68.6	29.8	38.6	52.0	272.4	141.5	23.4	221.2	6.0	1295.2
13-19years/male	56.4	523.2	44.4	49.3	92.8	34.2	42.4	47.9	328.1	229.1	20.4	317.5	22.8	1752.1
13-19years/female	50.0	422.3	40.1	44.0	68.9	32.9	43.0	57.0	336.5	186.4	29.5	281.9	3.5	1545.9
20-50years/male	63.0	530.3	57.0	52.3	92.6	31.0	53.3	42.0	379.8	151.5	36.7	296.5	107.5	1830.5
20-50years/female	56.0	453.5	44.3	46.9	70.8	33.9	45.0	39.9	356.2	163.2	39.3	268.0	22.4	1583.4
51-65years/male	65.0	522.1	68.5	48.9	84.3	37.3	51.5	60.7	390.3	189.0	57.4	344.9	49.2	1904.0
51-65years/female	58.0	443.1	58.1	44.3	57.4	34.6	41.1	55.8	352.9	158.5	37.4	300.3	28.2	1611.7
>65years/male	59.5	456.5	56.4	45.2	58.3	65.0	39.5	53.5	340.7	127.3	37.3	250.6	41.4	1571.6
>65years/female	52.0	365.7	39.6	40.9	52.5	32.1	40.7	38.2	316.7	133.1	25.8	176.6	15.9	1277.9

Table 2.1 Food consumption and average body weight of the 10 age/sex groups in the 2007 TDS.

This group of data is taken into consideration because people in different groups have different consuming habits, such as the consumption of alcohol beverage. This will be used to compare the users' eating habits with the the average consumption of the group they are in.

Table 2.2

Pb	黑龙江	辽宁	河北	陕西	河南	宁夏	上海	福建	江西	湖北	四川	广西	全国平均
Cereals	0.96	3.26	16.62	27.48	10.77	1.14	1.50	0.96	11.66	48.92	65.33	8.67	16.44
Legumes	13.00	16.66	8.82	0.06	0.10	0.43	0.39	0.16	0.76	0.92	2.61	5.37	4.11
Potatoes	5.95	45.14	2.12	9.57	0.92	0.42	0.06	0.04	0.61	1.68	0.64	1.31	5.70
Meats	0.05	29.32	0.52	0.02	1.23	1.34	3.10	0.12	3.05	0.67	0.36	0.07	3.32
Eggs	0.05	10.13	2.27	0.15	0.73	0.05	0.31	0.27	0.29	5.20	0.01	1.48	1.74
Aquatic foods	6.30	8.00	0.37	0.14	0.06	0.01	1.59	18.39	0.44	0.78	0.07	0.53	3.06
Dairy products	0.04	0.19	0.13	0.20	0.09	0.05	0.11	0.02	0.00	0.01	0.19	0.00	0.09
Vegetables	0.33	123.79	2.30	4.00	3.60	0.33	4.28	10.26	5.60	22.51	7.39	17.87	16.85
Fruits	0.28	1.02	0.39	0.34	2.32	1.78	1.33	0.66	1.06	0.26	0.07	21.32	2.57
Sugar	0.00	0.00	0.06	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Beverages and water	0.22	1.11	0.58	0.21	1.37	0.12	0.99	0.46	0.42	0.71	0.44	0.65	0.61
Alcohol beverages	0.01	0.09	0.03	0.01	0.01	0.00	0.03	0.01	0.02	0.03	0.01	0.01	0.02
SUM	27.19	238.71	34.21	42.18	21.22	5.67	13.70	31.33	23.90	81.69	77.13	57.29	54.52

Table 2.2 The Dietary contaminants intakes of adult male in 12 provinces(Pb) Unit: vg/d

This table contributes to providing the average daily food intake of adult males in 12 provinces directly, by dividing Table 2.2 by Table 1.1.

Table 2.3

Pb	黑龙江	辽宁	河北	陕西	河南	宁夏	上海	福建	江西	湖北	四川	广西	全国平均
Cereals	0.96	3.26	16.62	27.48	10.77	1.14	1.50	0.96	11.66	48.92	65.33	8.67	16.44
Legumes	13.00	16.66	8.82	0.06	0.10	0.43	0.39	0.16	0.76	0.92	2.61	5.37	4.11
Potatoes	5.95	45.14	2.12	9.57	0.92	0.42	0.06	0.04	0.61	1.68	0.64	1.31	5.70
Meats	0.05	29.32	0.52	0.02	1.23	1.34	3.10	0.12	3.05	0.67	0.36	0.07	3.32
Eggs	0.05	10.13	2.27	0.15	0.73	0.05	0.31	0.27	0.29	5.20	0.01	1.48	1.74
Aquatic foods	6.30	8.00	0.37	0.14	0.06	0.01	1.59	18.39	0.44	0.78	0.07	0.53	3.06
Dairy products	0.04	0.19	0.13	0.20	0.09	0.05	0.11	0.02	0.00	0.01	0.19	0.00	0.09
Vegetables	0.33	123.79	2.30	4.00	3.60	0.33	4.28	10.26	5.60	22.51	7.39	17.87	16.85
Fruits	0.28	1.02	0.39	0.34	2.32	1.78	1.33	0.66	1.06	0.26	0.07	21.32	2.57
Sugar	0.00	0.00	0.06	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Beverages and water	0.22	1.11	0.58	0.21	1.37	0.12	0.99	0.46	0.42	0.71	0.44	0.65	0.61
Alcohol beverages	0.01	0.09	0.03	0.01	0.01	0.00	0.03	0.01	0.02	0.03	0.01	0.01	0.02
SUM	27.19	238.71	34.21	42.18	21.22	5.67	13.70	31.33	23.90	81.69	77.13	57.29	54.52

Table 2.3: The Dietary contaminants intakes of adult male in 12 provinces and other provinces(include lead, cadmium, total mercury, methyl-mercury, total arsenic, and inorganic arsenic)

Note: The tables for Daily, weekly, and monthly (PTDI, PTWI and PTMI)Heavy Metal Exposure standard according to *JEFCA* and referring to *Chinese Nutrition Society(2016) Chinese dietary guide 2016*.

Table 3.1

Pb		
1-4 child	0.3 vg/(kg bw*d)	IQ decreases by 0.5
1-4 child	0.6 vg/(kg bw*d)	IQ decreases by 1
Adults	1.2 vg/(kg bw*d)	Increased blood pressure

Table 3.1 The effects of high Pb intake in different age groups

Table 3.2

	PTMI	PTWI	PTDI	BMDL01

Pb	25 vg/(kg bw*m)			
Cd		25 µg/kg bw/ month		
Mercury		4 vg/(kg bw)	0.5714 vg/(kg bw)/d	
Methyl mercury		1.6 vg/(kg bw)	0.2286 vg/(kg bw)/d	
As		0.015 mg/kg (bw*w)	0.00214 vg/(kg bw)/d	0.3-8 vg/ kg(bw*w)

Although there exists difference between daily, weekly or monthly heavy metal intake's effect on human body, since user's input is used to calculate the daily heavy metal intake, all the criterions above will be processed as daily metal intake standard by linear transformation.

Processed Data

Note: Some of the raw data above needed to be converted for calculation.

Table New.1

Build up a table which combines the sex, age, and the 12 provinces people intake of contaminants in 12 food categories and from which a food contaminants daily intake of average people of same province, age group and sex can be built

Assumption: the ratio between the contaminants intake of food categories of average people in one province in an age and sex group and that in adult male group(in Table 2.2) is, equal to the intake of food categories of average people in China in that age and sex group(in Table 2.1) and that in adult male group(in Table 2.1).

the contaminants intake of food categories of average people in one province= the contaminants intake of food categories of average people in adult male group*(the contaminants intake of food categories of average people in China in that age and sex group/the contaminants intake of food categories of average people in China in adult male group)

e.g. in Table 2.2, the lead(Pb) contaminant intake of adult male in Heilongjiang Province of Cereals is 0.96 vg/d

And in Table 2.1, we convert the average Chinese adult male's Cereals

intake=(530.3g+522.1g+456.5g)/3=497.6g

average Chinese Male in 13-18's Cereal intake is 523.3g,

then the contaminants intake of food categories of average male in 13-18 in Heilongjiang province=0.96*523.3/497.6=1.0096

Table New.2

How to use the existed data to presume the data of the other provinces other than the 12 provinces is the next we consider. Since we need to make the data more precise, to use the average of country's contaminants is arbitrary.

Firstly, we consider using the similarity between some nearby provinces. The reason is, that in the nearby provinces, the geography environment are more similar than the provinces far away, which will partially contribute to the similarity of the eating habits and the contaminants quantity.

In the next place, we need to find a criterion to define the ‘similarity’; According to comprehensive physical regionalization of China(Regionalization of China, https://baike.baidu.com/item/中国地理区划/4221764?fr=aladdin, August 6), we divide it into 7 part. In every part, there exist at least one province which already has the raw data.



picture 1 In this picture, China are divided into 7 parts in 7 colors respectively. The big words in each area are the provinces in this area which already have the raw data(in another words, which are in the 12 provinces)

After area division, we used the Average of existed data in the provinces in one part to generalize the data of the other provinces.

Unknown data of province= Average(data of all the provinces which have existed data and in the same parts in division)

For instance, for the North-east Area, which contains Heilongjiang and Liaoning(existed data), Jilin and Neimenggu-East(unknown data),

the data of Jilin and Neimenggu-East=(Heilongjiang+Liaoning)/2

The reason behind simple usage of average of provinces in same area instead of weighting is there is no exist standard for weighting.

Table New 2.1: Contaminants level in food samples in 12 provinces and other provinces(include lead, cadmium, total mercury, methyl-mercury, total arsenic, and inorganic arsenic)

各省12种类食物重金属含量

已有				推测
P229 铅 附表 4-12				
膳食种类	黑龙江	辽宁		
谷类	1.50	6.46		3.98
豆类	220.97	285.03		253.00
薯类	112.68	307.65		210.17
肉类	0.94	427.09		214.02
蛋类	0.90	151.48		76.19
水产类	220.60	343.63		282.12
乳类	0.75	2.12		1.44
蔬菜类	0.88	224.81		112.85
水果类	0.78	6.17		3.48
糖类	0.75	0.75		0.75
饮料与水	0.75	5.47		3.11
酒类	0.75	4.36		2.56

成年男子十二类食物中的重金属来源量

已有				推测（吉林 内蒙）
Pb	黑龙江	辽宁		
Cereals	0.96	3.26		2.11
Legumes	13.00	16.66		14.83
Potatoes	5.95	45.14		25.545
Meats	0.05	29.32		14.685
Eggs	0.05	10.13		5.09
Aquatic foods	6.30	8.00		7.15
Dairy products	0.04	0.19		0.115
Vegetables	0.33	123.79		62.06
Fruits	0.28	1.02		0.65
Sugar	0.00	0.00		0.00
Beverages and water	0.22	1.11		0.665
Alcohol beverages	0.01	0.09		0.05
SUM	27.19	238.71		132.95

Table New 2.1(Partiality, north-east area and Lead) In this table, we calculate the average Lead contaminants in 12 food class of Heilongjiang and Liaoning to as of the Jilin and Neimenggu-East.

表格 1

3-6宁夏回族自治区			3-4陕西省			
谷类	米饭	Cooked rice	谷类	馒头	Steamed	0.027
	馒头	Steamed		煮好的米饭	Cooked rice	0.010
	挂面	Dried		米粥	Rice congee	0.004
	烧饼	Sesame seed		小米粥	Millet	0.014
	小米粥	Millet		玉米粗燕麦	Corn grits	0.026
	小计	Subtotal		油炸面团蛋糕	Deep-fried dough cake	0.201
	炖豆腐	Stewed bean		面包	Bread	0.077
	小计	Subtotal		糕点汤	Pastry soup	0.022
薯类	炒土豆	Stir-friend shredded		面条汤	Noodle soup	0.039
	小计	Subtotal		煮面条	Boiled	0.028
肉类	炒猪肉片	Stir-fried		小计	Subtotal	
	炖小鸡金块	Stewed chick nugget	豆类	豆腐	Bean curd	0.058
	切牛肉	Sliced beef		豆浆	Soybean	0.017
	炒羊肉片	Stir-fried		干豆腐	Dried bean	0.076
	小计	Subtotal		内核	Kernel	0.029
蛋类	炒蛋	Scrambled		大豆	Soybean	0.019
	煮鸡蛋	Boiled egg		小计	Subtotal	
	鸡蛋汤	Egg soup	薯类	土豆片	Potato slices	0.021
	小计	Subtotal		马铃薯淀粉的面条	Potato starch	1.546
乳类	牛奶	Milk		蒸熟的红薯	Steamed sweet potato	0.011
	奶粉	Milk powder		小计	Subtotal	
	酸奶	Yogurt	肉类	猪肉	Pork	0.019
	小计	Subtotal		鸡腿	Chicken	0.030
				火腿香肠	Ham	0.022
				小计	Subtotal	
			蛋类	炒蛋	Scrambled	0.019
				咸鸭蛋	Salted duck	0.009
				小计	Subtotal	
			乳类	牛奶	Milk	0.014
				奶粉	Milk powder	0.014
				小计	Subtotal	

Table New 2.2(Partiality, north-east area and Lead)

Table New 2.3 The levels of lead and cadmium in individual diet samples in 12 provinces

However, the The levels of lead and cadmium in individual diet samples in 12 provinces cannot be directly generalized to other provinces, for in the

data table, we can see that in different provinces, the type of diet samples are different, and even the same diet samples some times have different names.

In the left picture, partial of the dietary samples of Ningxia and Shanxi Provinces in North-west area, the name and types of the food are different.

As a result, we first choose the overlapping type of food of the provinces in same area, convert the name into the same one, and calculate the average of the overlapping area food's contaminants quantity.

Access	
Table 2.2: Contaminants level in food samples in 12 provinces(include lead, cadmium, total mercury, methyl-mercury, total arsenic, and inorganic arsenic)	contaminant in general food(CGF)
Table New 2.3 The levels of lead and cadmium in individual diet samples in 12 provinces	contaminants in specific food(CSF)

合并combinatied						推测predicted		
		陕西Shanxi		宁夏Ningxia		（统一使用第一个省的命名）		
		Pb/（mg/kg）	Cd/（pg/kg）	Pb/（mg/kg）	Cd/（pg/kg）		Pb/（mg/kg）	Cd/（pg/kg）
馒头	Steamed bun	0.027	5.77	0.002	0.60		0.015	3.19
煮好的米饭	Cooked rice	0.010	3.06	0.002	0.60		0.006	1.83
小米粥	Millet congee	0.014	2.15	0.002	0.60		0.008	1.38
煮面条	Boiled noodle	0.028	2.99	0.002	0.60		0.015	1.80
豆腐	Bean curd	0.058	5.37	0.016	4.35		0.037	4.86
土豆片	Potato slices	0.021	3.050	0.003			0.012	3.05
猪肉	Pork	0.019	1.93	0.035	2.83		0.027	2.38
鸡腿	Chicken drumstick	0.030	0.66	0.050	4.52		0.040	2.59
炒蛋	Scrambled egg	0.019	0.41	0.018	2.14		0.019	1.28
牛奶	Milk	0.014		0.005			0.010	
奶粉	Milk powder	0.014					0.014	
鲤鱼	Carp	0.032		0.026	2.60		0.029	2.6
芸豆	Kidney bean	0.009	1.14	0.017	3.43		0.013	2.29
黄瓜	Cucumber	0.008	1.18	0.005	2.27		0.007	1.73
胡萝卜	Carrot	0.011	1.72	0.026	3.14		0.019	2.43
番茄	Tomato	0.014	4.05	0.014	9.17		0.014	6.61
茄子	Eggplant	0.004	9.28	0.019	10.20		0.012	9.74
白菜	Chinese cabbage	0.015	9.89	0.016	12.25		0.016	11.07
芹菜	Celery	0.014	1.94	0.036	8.28		0.025	8.28
苹果	Apple	0.006	0.59	0.002			0.004	0.59
枣类	Date	0.045	3.09	0.090			0.068	3.09
梨（average）	Pear（average）	0.026	1.84	0.015			0.0255	1.84

Table New.2.3(partiality, the north-west area's Shanxi and Ningxia(existed), Xinjiang Gansu, Qinghai, Neimenggu-West)

Table New.3:
according to *Chinese dietary guide 2016*, we get the range of daily recommended food intake of people. In the bellowing graph, the columns with name 2 and 3 are the the range of daily recommended food intake of people.
column 1=column2-range
column 4=column3+range
By dividing the intake level in 5 parts(very low, low ,medium, high, very high) by 4 value, Columns 1,2,3,4 are combined to use to make the interface for the user to choose the quantity they eat easier.

饭量标准设定（参照中国居民平衡膳食宝塔2016）g/day 参考人：61.25kg

	1	2	3	4
Cereals	100	200	300	400
Cereals（转换后）	222	444	666	888
Legumes	15	25	35	45
Potatoes	0	50	100	150
Meats	5	40	75	110
Eggs	30	40	50	60
Aquatic foods	5	40	75	110
Dairy products		300	300	
Vegetables	100	300	500	700
Fruits	50	200	350	500
Sugar	0			0
Beverages and water	1300	1500	1700	1900
Alcohol beverages	0			0

Table New 3

In addition, the Cereals recommended intake is the raw food intake, so according to the ratio food/raw food=2.22, we change the raw food into fine food.

Strategy

Note: This part analyzes the calculating logic and process.

1. The daily intake of one contaminant per body weight=Sum (food consumptions * contaminants in different food) / weight

input	explanation	input	explanation
age	To build a more specific portrait of user, which will help to make comparison with other group of people and the assessment of contaminants intake,	12 food class&the quantity of food	special interface is set to make the frame easier
sex		specific food intake proportion	the contaminants of the specific food are correspond to some of the specific data.
weight		general food intake proportion	the contaminants of these food are generalized based on existed data
province			

Since the input includes 12 food class&the quantity of food, specific food intake proportion and general food intake proportion,

Every specific food intake weight(SFIW)=quantity of food of food class* specific food intake proportion

Every general food intake weight(GFIW)=quantity of food of food class* general food intake proportion

We access Table 1.1: Contaminants level in food samples in 12 provinces(include lead, cadmium, total mercury, methyl-mercury, total arsenic, and inorganic arsenic) and Table New 2.3 The levels of lead and cadmium in individual diet samples in 12 provinces.

For Lead and Cadmium,

The daily quantity intake of one contaminant=Sum(CGF*GFIW)+Sum(CSF*SFIW)

then,

The daily quantity intake of one contaminant of body weight=Sum(CGF*GFIW) +Sum(CSF*SFIW)/weight

For total mercury, methyl-mercury, total arsenic, and inorganic arsenic

The daily quantity intake of one contaminant of body weight=Sum(CGF*GFIW)/weight

2. Compare the daily intake of one contaminant of body weight of users (DIBWu)with that of average people in the same province(DIBWp) and that of average Chinese people(DIBWC) and that of the Chinese criterion(DIBWc).

Ratio (x)=DIBWu/DIBWx, for x is u, C or c

if Ratio(x)>1, the user's contaminants intake is over that value.

if Ratio(x)<1, the user's contaminants intake is less than value.

convert ratio to percentage.

3. See if the partial contaminant intake of food class are over the criterion.

First, we build a criterion in different food categories based on the total Chinese criterion(Cc), Chinese average contaminants quantity(CAC) and the Table New 3.

Assumption: the fraction of different criterion parts of contaminants is equal to that of those of actual intake of a people whose intake is accord with Table 4(Std_q).

Partial Criterion(Pc)

Pc=(Std_q(x)*CAC(x))/Sum(Std_q(x)*CAC(x))

If the user's heavy metal intake exceeds the partial criterion, output will show this result.

4. Recommending a healthier diet.

For Pb and Cd, Build up the box-plot of food sample in every food category to see if the food the person has eaten is the outlier in that box-plot.

However, As for the predicted provinces, the number of food samples are too small (mostly less than 3 in each food category) for it was the overlap of other provinces in the same area. As a result, we build the box-plot for all the type of food existed in the table.

if contaminants quantity of food>Q3, we will out put the food as not recommended. Also, if the input of food appeared in the output, we would highlight that food. For all the contaminants which have contaminants contents in each food category, we will also build up box-plot for each contaminants in each food class and output the outlier.

The Overview of the Calculation System

We produce a user, and let he go through the whole process to clearly show it.

1. Personal information and food choice

Age	55	weight(kg)	75
Gender	male	Province	Hubei

To see the Example of interface, see Appendix 3

Access table new 1, new 2.1, new 2.2 and new2.3.

2. According to the food the user choice, we will append the contaminants quantity accord with the food. For the specific heavy metal quantity of each specific food or food class, see Appendix.2

To make the data of Pb and Cd more precise, we don't use the above graph. Instead, we use the following graph which contain more specific food types to make the calculation.
To see the complete process of user's contaminants daily intake calculation, see Appendix.1

3. Get the daily intake per body weight and compare it with Chinese criterion(Cc), Chinese average contaminants quantity(CAC) for his age (male 50-65) and the Table New 3.

	Pb(vg/kg/bw/d)	Cd(vg/kg/bw/d)	Hg(vg/kg/bw/d)	Methyl-mercury(vg/kg/bw/d)	total arsenic (mg/kg/bw/d)	inorganic arsenic (vg/kg/bw/d)
User	0.071	17.704	0.031	0.000	0.001	0.387
Cc	3.570	0.833	0.571	0.229	0.002	0.043
CAC	0.711	0.365	0.023	0.000	0.001	0.270
Table New 3(average in take of people of the same age and province)	1.257	0.313	0.032	0.000	0.001	0.538

When the calculation is based on CC as standard 1:

	Pb(vg/kg/bw/d)	Cd(vg/kg/bw/d)	Hg(vg/kg/bw/d)	Methyl-mercury(vg/kg/bw/d)	total arsenic (mg/kg/bw/d)	inorganic arsenic (vg/kg/bw/d)
User	0.020	21.253	0.055	0.001	0.296	9.031
Cc	1.000	1.000	1.000	1.000	1.000	1.000
CAC	0.199	0.439	0.041	0.001	0.259	6.312

	Pb(vg/kg/bw/d)	Cd(vg/kg/bw/d)	Hg(vg/kg/bw/d)	Methyl-mercury(vg/kg/bw/d)	total arsenic (mg/kg/bw/d)	inorganic arsenic (vg/kg/bw/d)
Table New 3(average in take of people of the same age and province)	0.352	0.375	0.057	0.001	0.370	12.574

4. of the Cd and Pb's individual foods recommendation and advice,

Q3 of Pb =0.157, while Q3 of Cd=19.595, the list of foods greater than the Q3 is below:

Pb(not to eat)		Cd(not to eat)	
kernel	Edible amaranth	Bun	Cowpea
Preserved egg	Dayflower	Sesame seed cake	Edible amaranth
Bean	Pepper	tofu	Dayflower
Eggplant	Small Chinese cabbage	Kernel	Pepper
Sponge gourd	Salted vegetable	Bean sandwich	Small Chinese cabbage
		Pork liver	Salted vegetable

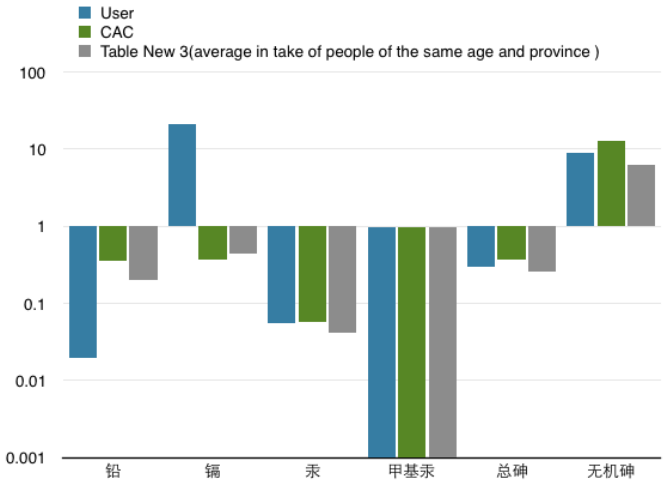
of all the contaminants foods category advice,

since the ratio=c of province/ c of average of China>3 will be output as not recommended, the list is:

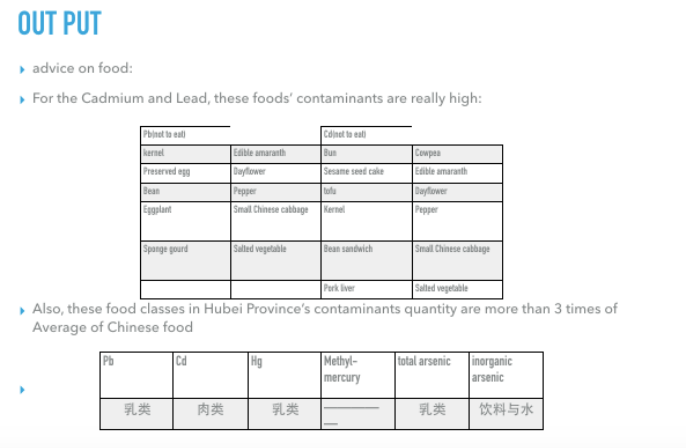
Pb	Cd	Hg	Methyl-mercury	Total arsenic	Inorganic arsenic
Dairy products	Meats	Dairy products	—————	Dairy products	Beverages and water

4. Out put

a. Evaluation: According the graph below, your intakes of Cadmium and inorganic arsenic higher than criterion, which are more than 10 times of criterion and about 10 times of criterion, respectively.



b. Recommendation of food intake:



References

Chinese Nutrition Society(2016) Chinese dietary guide 2016. 1st edn. People's Medical Publishing House

Yongning Wu & Li youwei(2015) The Fourth China Total Diet Study.1st edn. Beijing: Chemical Industry Press.

Appendix

Appendix 1

Food				Contaminants (According to the Table new 2.3)			
Food class	Very low, low, medium, high, very high	food	percentage	Pb (mg/kg)	Cd(vg/kg)		
Cereal	High	Rice	60	0.122	24.42	7.32	1465.2
		Rice Porridge	10	0.018	16.16	0.18	161.6
		noodle	25	0.023	8.64	0.575	216
		Other	5	0.046	20.76	0.23	103.8
Legumes	medium	kernel	20	13.935	170.03	278.7	3400.6
		tofu	20	0.039	16.9	0.78	338
		Other	60	2.828	45.07	169.68	2704.2
Potatoes	medium	Potato	60	0.148	5.03	8.88	301.8
		Other	50	0.116	4.26	5.8	213
Meats	Extremely high	Minced meat	10	0.007	0.88	0.07	8.8
		Lean meat	30	0.005	14.78	0.15	443.4
		Chicken	20	0.005	0.61	0.1	12.2
		Pork liver	20	0.041	4994.94	0.82	99898.8
		Other	20	0.016	1005.70	0.32	20114
Eggs	medium	Scrambled eggs	80	0.003	0.20	0.24	16
		Preserved egg	20	1.079	7.60	21.58	152

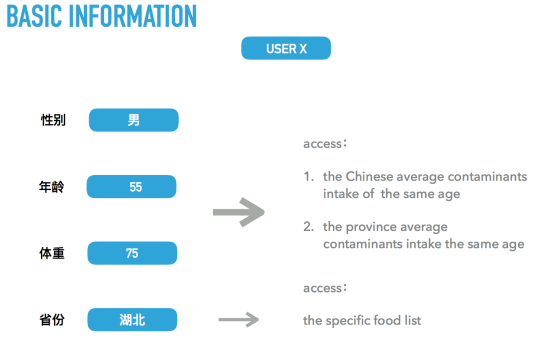
Aquatic foods	medium	lobster	50	0.022	2.38	1.1	119
		Other	50	0.092	12.27	4.6	613.5
Dairy products	medium	milk	50	0.002	0.09	0.1	4.5
		Other	50	0.002	0.09	0.1	4.5
Vegetables	low	eggplant	20	0.172	17.13	3.44	342.6
		Salted vegetable	20	0.678	31.30	13.56	626
		Chinese cabbage	30	0.170	19.88	5.1	596.4
		Other	30	0.188	19.63	5.64	588.9
Fruits	low	Banana	10	0.054	0.82	0.54	8.2
		Watermelon	10	0.002	0.29	0.02	2.9
		Other	80	0.04	3.64	3.2	291.2
Sugar	0					0	0
Beverages and water	high	Other	100	0.01	0.34	1	34
Alcohol beverages	0					0	0
sum						5.33825	1327.811
/ bodyweight						0.071	17.704

Appendix 2

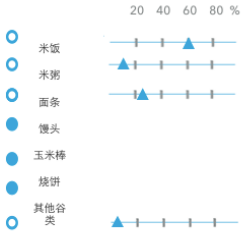
	weight(g)	Hg(vg/kg)	Methyl-mercury(vg/kg)	total arsenic (mg/kg)	inorganic arsenic (vg/kg)	Hg(vg/kg)	Methyl-mercury(vg/kg)	total arsenic (mg/kg)	inorganic arsenic (vg/kg)
Cereals	777	0.46		0.015	20.20	357.42		11.655	15695.4
Legumes	30	0.26		0.001	3.99	7.8		0.03	119.7

	weight(g)	Hg(vg/kg)	Methyl-mercury(vg/kg)	total arsenic (mg/kg)	inorganic arsenic (vg/kg)	Hg(vg/kg)	Methyl-mercury(vg/kg)	total arsenic (mg/kg)	inorganic arsenic (vg/kg)
Potatoes	75	0.07		0.001	0.78	5.25		0.075	58.5
Meats	145	1.02		0.030	8.24	147.9		4.35	1194.8
Eggs	45	9.22		0.008	0.72	414.9		0.36	32.4
Aquatic foods	57.5	10.30	9.76	0.151	1.40	592.25	9.76	8.6825	80.5
Dairy products	300	2.23		0.032	13.46	669		9.6	4038
Vegetables	200	0.34		0.036	9.73	68		7.2	1946
Fruits	125	0.05		0.001	0.66	6.25		0.125	82.5
Sugar	0	0.05		0.001	0.65	0		0	0
Beverages and water	1800	0.05		0.003	3.19	90		5.4	5742
Alcohol beverages	0	0.05		0.005	0.65	0		0	0
Sum						2358.77	9.76	47.4775	28989.8
/body weight/ 1000						0.031450	0.000130	0.000633	0.386530

Appendix 3



食物选择



FOOD CHOICE

选择食物类别

- 谷类
- 豆类
- 薯类
- 肉类
- 蛋类
- 水产类
- 乳类
- 蔬菜类
- 水果类
- 糖类
- 饮料与水
- 酒类

谷类

Ex- low low medium high Ex-high

222 444 666 888 (g)

参照：100g米饭

